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[0062] The sealing of fluid in cavity 242 is provided by a labyrinth-like flow path through seal and bearing assembly 200. That is, fluid pressure in housing 204 will cause fluid to flow to radially inwardly toward seal and bearing assembly 200. Any fluid leaked must flow between annular portion 254 of outer race 244 and outer groove 236 through the corresponding gap 258, around cage 248 and bearing elements 252 between first and second bearing surfaces 260 and 262, and between annular portion 256 of first race 244 and inner groove 238 through the other gap 258. All of the components are sized with close tolerances so that there is a significant pressure drop through this flow passageway which results in a relatively low pressure radially inwardly of seal and bearing assembly 200 and minimal leakage. The fluid flow that does occur also provides lubrication for bearing elements 252 and bearing surfaces 260 and 262 and also provides lubrication for carrier bearings 232.

[0063] Although second embodiment seal and bearing assembly 200 has been described as having certain rotating components and stationary components, those skilled in the art will see that these rotating and stationary components can be reversed and that the seal and bearing assembly 200 will function in the same manner.

[0064] It will be seen, therefore, that the seal and bearing assembly of the present invention is well-adapted to carry out the ends and advantages mentioned, as well as those inherent therein. While presently preferred embodiments of the invention have been described for the purposes of this disclosure, numerous changes in the arrangement and construction of parts may be made by those skilled in the art. All such changes are encompassed within the scope and spirit of the appended claims.

[0065] What is claimed is:

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1. A seal for use adjacent to a rotating surface and a stationary surface and comprising:
- a ring having a sealing surface for substantially sealing between at least a portion of said stationary surface and said sealing surface, said ring further having a race engagement surface thereon;
- a first race adapted for engagement with at least a portion of said rotating surface and rotation therewith;
- a second race adapted for engagement with said race engagement surface;
- and
- a plurality of bearing elements disposed between said first and second races.
2. The seal of claim 1 further comprising a bearing cage defining a plurality of bearing openings therein disposed between said first and second races, wherein said bearing elements are disposed in said bearing openings.
3. The seal of claim 1 wherein said sealing surface is an outer peripheral surface of said ring.
4. The seal of claim 1 wherein:
- said first race has a substantially planar first bearing surface thereon;
- said second race has a substantially planar second bearing surface thereon;
- and
- said first and second bearing surfaces are substantially parallel.

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5. The seal of claim 3 wherein said bearing elements engage said first and second bearing surfaces.
6. The seal of claim 4 wherein said bearing elements are rollers.
7. The seal of claim 1 wherein:
said first race defines a recess therein; and
said second race and bearing elements are disposed in said recess.
8. The seal of claim 1 wherein:
said ring defines a pair of annular grooves therein; and
said first race comprises a pair of annular portions, each of said portions extending into one of said grooves.
9. The seal of claim 8 wherein said grooves are substantially concentric.
10. The seal of claim 8 wherein ends of said annular portions are spaced from bottom surfaces of said grooves.
11. The seal of claim 8 wherein said race engagement surface of said ring is between said grooves.
12. The seal of claim 1 wherein said bearing elements are rollers.

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13.

The seal of claim 1 wherein:

said race engagement surface is one of a pair of race engagement surfaces disposed on opposite sides of said ring;

said first race is one of a pair of first races engaging different portions of said rotating surface on opposite sides of said ring;

said second race is one of a pair of second races disposed on opposite sides of said ring and engaging a corresponding one of said race engagement surfaces; and

said bearing elements are disposed between corresponding ones of said first and second races.

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14. An apparatus comprising:
- a stationary housing having a housing sealing surface therein;
- a rotor rotatably disposed in said housing;
- a ring having a ring sealing surface thereon for substantially sealing along at least a portion of said housing sealing surface and further having a bearing race engagement surface thereon;
- a first bearing race adapted for engagement with at least a portion of said rotor and rotatable therewith;
- a second bearing race adapted for engagement with said race engagement surface;
- a bearing cage defining a plurality of bearing openings therein disposed between said first and second bearing races; and
- a plurality of bearing elements disposed in said bearing openings.
15. The apparatus of claim 14 wherein:
- said housing sealing surface is substantially cylindrical; and
- said ring sealing surface is substantially concentric with said housing sealing surface.
16. The apparatus of claim 15 wherein said ring sealing surface is an outer peripheral surface of said ring.

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The apparatus of claim 14 wherein:

said first bearing race has a substantially planar first bearing surface thereon;

said second bearing race has a substantially planar second bearing surface thereon; and

said first and second bearing surfaces are substantially parallel.

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The apparatus of claim 17 wherein said bearing elements engage said first and second bearing surfaces.

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The apparatus of claim 18 wherein said bearing elements are rollers.

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The apparatus of claim 14 wherein:

said first bearing race defines a recess therein; and

recess.

21.

The apparatus of claim 14 wherein:

said ring defines a pair of substantially concentric annular grooves therein;

and

said first bearing race comprises a pair of annular portions, each of said portions extending into one of said grooves.

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22. The apparatus of claim 21 wherein ends of said annular portions and facing bottom surfaces of said grooves define a gap therebetween.
23. The apparatus of claim 21 wherein said race engagement surface of said ring is between said grooves.
24. The apparatus of claim 14 wherein said bearing elements are rollers.
25. The apparatus of claim 14 wherein:
- said race engagement surface is one of a pair of race engagement surfaces disposed on opposite sides of said ring;
- said first bearing race is one of a pair of first bearing races engaging different portions of said rotor on opposite sides of said ring;
- said second bearing race is one of a pair of second bearing races disposed on opposite sides of said ring and engaging a corresponding one of said race engagement surfaces; and
- said bearing cage is one of a pair of bearing cages disposed between corresponding ones of said first and second races with bearing elements disposed in the bearing openings of the bearing cages.

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26. A seal for use adjacent to a rotating race engagement surface and a stationary surface and comprising:

a first race adapted for engagement with one of said rotating race engagement surface and said stationary surface, said first race defining outer and inner annular portions;

a second race adapted for engagement with the other of said race engagement surface and stationary surface, said second race being disposed between said annular portions of said first race; and

a plurality of bearing elements disposed between said first and second races.

27. The seal of claim 26 further comprising a bearing cage defining a plurality of bearing openings therein disposed between said first and second races, wherein said bearing elements are disposed in said bearing openings.

28. The seal of claim 26 wherein:

said first race has a substantially planar first bearing surface thereon;

said second race has a substantially planar second bearing surface thereon;

and

said first and second bearing surfaces are substantially parallel.

29. The seal of claim 28 wherein said bearing elements engage said first and second bearing surfaces.

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30. The seal of claim 28 wherein said bearing elements are rollers.
31. The seal of claim 26 wherein one of said rotating race engagement surface and said stationary surface defines a pair of annular grooves therein; and each of said annular portions of said first race extends into one of said grooves.
32. The seal of claim 31 wherein said annular portions are substantially concentric.
33. The seal of claim 31 wherein ends of said annular portions are sized to be spaced from bottom surfaces of said grooves.
34. The seal of claim 26 wherein said bearing elements are rollers.